

## CONJOINT SCHEDULES OF TIMEOUT DELETION IN PIGEONS

TIMOTHY D. HACKENBERG

UNIVERSITY OF MINNESOTA

This experiment attempted to bring behavior under joint control of two distinct contingencies, one that provided food and a second that extended the periods during which that food was available. Pigeons' responses on each of two keys were reinforced according to a single random-interval schedule of food presentation except during signaled timeout periods during which the schedule was temporarily disabled. By means of a conjoint schedule, responses on the initially less preferred key not only produced food but also canceled impending timeouts. When behavior came to predominate on this conjoint alternative, the consequences of responding on the two keys were reversed. Responding in 3 of 4 pigeons proved sensitive to the conjoint scheduled consequences, as evidenced by systematic shifts in response rates favoring the conjoint key. In 2 of these 3 pigeons, sensitivity to the conjoint contingency was evident under time-in:timeout ratios of 2:1 (time-in = 120 s, timeout = 60 s) and 1:5 (time-in = 30 s, timeout = 150 s), whereas for the other pigeon preference for the conjoint key was observed only under the latter sequence of conditions. There was only weak evidence of control by the conjoint scheduled consequences in the 4th subject, despite extended training and forced exposure to the conjoint alternative. The overall pattern of results is consistent with studies of timeout avoidance but also shares features in common with positively reinforced behavior.

*Key words:* timeout avoidance, negative reinforcement, positive reinforcement, choice, conjoint schedules, scales of analysis, key peck, pigeons

A conjoint reinforcement contingency involves two or more consequences simultaneously contingent on a single pattern of activity (Catania, Deegan, & Cook, 1966). Such conjoint control of behavior captures many features of what is commonly termed *multiple causation*—an action jointly determined by the simultaneous confluence of two or more variables. Thompson and Lubinski (1986) offer an example of an employee's rate of productivity that reflects joint control by ratio contingencies imposed by an employer and pacing contingencies imposed by a co-worker. To the degree that these distinct consequences gain

control over behavior, the resulting performance reflects the integration of multiple response classes. If control by one set of contingencies were to weaken (e.g., by an argument with the co-worker), one would expect the alternate contingencies to prevail.

Conjoint schedules involve explicit interaction among constituent response units. Interactions are especially common when the component contingencies are interconnected, as when, for example, behavior is under joint control of a reinforcement schedule and a second schedule governing transitions to or away from the first. Some of the clearest demonstrations of such conjoint control come from studies of negatively reinforced behavior in which responses both avoid individual shocks and provide escape from the schedule of shock delivery (Baron, DeWaard, & Lipson, 1977; DeWaard, Galizio, & Baron, 1979). DeWaard et al. studied rats' responding on two-link chained schedules of negative reinforcement. Initial-link responses canceled one shock per minute on average and, by means of a conjoint ratio schedule, produced transitions to a terminal-link situation in the presence of which shock density was varied across different

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experimental conditions. Initial-link response rates were a decreasing function of obtained shock rates in the terminal links. Stated more broadly, initial-link responding was maintained by canceling individual shocks and by transitions from patterns of more frequent to less frequent shock.

Also using conjoint procedures, Mellitz, Hineline, Whitehouse, and Laurence (1983) demonstrated effects similar to those reported by DeWaard et al. (1979), but on a greatly expanded time scale. A shock-postponement contingency was arranged for rats' responses on either of two levers. Responses on one of the levers not only postponed the next scheduled shock but also subtracted 1 min from the overall session duration (which began at 152 min). Responding predominated on the lever with the conjoint scheduled consequences, an effect that, for most rats, was replicated when the consequences of responding on the two levers were reversed. As in the DeWaard et al. study, responding had the dual consequences of avoiding individual shocks and of terminating the situation in which those shocks were delivered (in this case, the avoidance contingency altogether). As the authors note, such sensitivity may have depended on their use of a two-response procedure, which allowed additional sources of control to establish and maintain lever pressing.

The present line of research was a preliminary investigation of conjoint control of pigeons' key pecking by schedules of positive reinforcement. A choice procedure similar to that of Mellitz et al. (1983) was used, in which responses on either of two simultaneously available alternatives were reinforced on a random-interval (RI) schedule of food delivery. Responses on the conjoint alternative, rather than reducing exposure to aversive contingencies as in the Mellitz et al. study, increased exposure to a schedule of positive reinforcement by canceling signaled periods of extinction (timeouts) from that schedule. Two distinct sources of reinforcement were thus simultaneously arranged for a single pattern of responding—one that produced food and another that extended the period of time during which that food was available. Sensitivity to the conjoint contingency was assessed by the degree to which responding shifted in favor of the key on which the multiple consequences were arranged.

## METHOD

### *Subjects*

Four adult male White Carneau pigeons (*Columba livia*), obtained from the Palmetto Pigeon Plant and maintained at approximately 80% of their free-feeding weights, served as subjects. The pigeons (designated T1, T2, T3, and T4) had served briefly in pilot research related to the present study but were otherwise experimentally naive. Each pigeon was individually housed and had continuous access to water and grit.

### *Apparatus*

A standard Gerbrands conditioning chamber (32 cm by 32 cm by 30 cm) enclosed in a sound-attenuating shell was used. Two 7-W houselights, located on the ceiling of the chamber, provided diffuse illumination. The chamber contained three horizontally aligned round translucent response keys, but only the two sides keys were used; the center key was inoperative and covered with black tape. The two side keys, each measuring 2 cm in diameter and mounted 22 cm above the grid floor, were 14.5 cm apart and could be transilluminated from the rear with blue light. Sufficiently forceful pecks on either key (approximately 0.6 N) produced auditory feedback via an externally mounted relay. A solenoid-operated food hopper provided occasional access to mixed grain through a centrally located aperture. During these brief periods, the grain was illuminated with white light while the houselights and both keylights were extinguished. Programming of events and recording of data were performed by a PDP-8E® minicomputer with accompanying SuperSKED® software (Snapper & Inglis, 1978) located in an adjacent room.

### *Procedure*

*Initial training.* Following magazine training, both side keys were illuminated blue, a single peck on which was reinforced with 2.5 s access to food. When key pecking was acquired, the probability of reinforcement was gradually reduced until it occurred only about once every 45 s according to an RI schedule. This was achieved by arranging availability of reinforcement each second with a probability of .022. Once arranged, food deliveries remained available until a response occurred.

The RI timer ran continuously except during hopper cycles and between food setup and delivery. Once pecking was maintained under this schedule, the pigeons received several sessions of forced exposure to each key. In this phase, blue-key responses were still reinforced with food on the RI schedule, but only one of the two keys was blue at any given time; responses on the inoperative (dark) key produced no scheduled consequences. The position of the blue RI key was assigned randomly following each food delivery.

*Experimental procedure.* To minimize position preferences, the forced-alternation contingency introduced during initial training remained in effect throughout the experiment, but was reduced to approximately 12 min immediately prior to each session. Immediately following the first food delivery after 12 min had elapsed, the session proper began, with the following conditions in effect: The side keys were either both blue or they were both dark. When blue, responses on either key were reinforced according to a single RI 45-s schedule; when dark, the schedule of food delivery was temporarily disabled (timeout period). During timeouts, dark-key responses were counted but were ineligible for reinforcement. Timeouts also canceled any potential food deliveries arranged, but not collected, during the preceding RI cycle. Following a timeout, both keys were lit and the RI schedule resumed.

Under baseline conditions, 60-s timeout periods occurred irrespective of responding every 120 s (fixed time 120 s). In the first experimental phase, a conjoint contingency was superimposed on one of the two keys. In addition to producing food on the RI schedule, responses on this key could also cancel the next programmed timeout period. To avoid a possible confounding effect of position preference with the effects of this timeout-deletion contingency, the conjoint schedule was initially arranged on the less preferred key, as assessed during the terminal baseline sessions. Technically, the timeout-deletion contingency was a fixed-ratio schedule, the requirements of which were satisfied by a certain number of pecks on the conjoint key. Ratio responses were counted during the 120-s RI component of each 180-s time-in : timeout cycle. Conjoint ratio requirements were reset with the onset of each RI cycle, such that timeout deletion was contingent on the same number of pecks from

one cycle to the next. If a particular timeout was canceled, the next time-in cycle, with its accompanying ratio requirements, would begin immediately. Other than timeouts (when allowed to occur), there were no stimuli correlated with transitions between cycles. Sessions terminated following the first completed cycle after 45 min. At session's end, the houselights and both keylights were extinguished.

Because the effects of the conjoint contingency were measured as shifts in the overall distribution of responding, ratio size had to be sufficient to produce sizable changes in response allocation. For this reason, ratio requirements were determined individually for each subject and were based on overall response rates. Based on preliminary work, ratio size on the conjoint key was arranged such that canceling all scheduled timeouts would require conjoint response rate to absorb a 40% reduction in response rate on the other (preferred) key, assuming no change in overall (combined left-key and right-key) response rate. To provide a concrete example, mean response rates for Pigeon T4 were 172 per cycle (left key) and 41 per cycle (right key) over the final six baseline sessions. With no change in overall rate, a 40% reduction in left-key responding would yield 103 responses per cycle and 110 responses per cycle on left and right keys, respectively. Thus, the conjoint ratio requirement for this subject was set at 110 responses per 120-s time-in period. Because overall rates did vary over time, however, ratio size was redetermined prior to each condition, thereby ensuring that the conjoint contingency was equally stringent across conditions.

During each pigeon's initial exposure to the conjoint schedule, measures were taken to ensure reliable contact with the consequences of responding on that alternative. This was accomplished with a forced-choice procedure in which the nonconjoint key was darkened and rendered inoperative. During sessions of this type, pecking was maintained on the lighted (conjoint) key at a rate sufficient to cancel a high percentage of the programmed timeouts. For Pigeons T1 and T4, forced-choice sessions of this type alternated with unforced-choice (two-key) sessions until relative response rates shifted in favor of the conjoint key for three consecutive two-key sessions, at which time the forced-choice sessions were discontinued for the remainder of the experiment. When rel-

ative response rates had stabilized for these 2 pigeons, the consequences of responding on the two keys were reversed (i.e., the conjoint contingency was transposed to the other key).

Despite forced contact with the conjoint scheduled consequences, position bias precluded effective contact with the conjoint contingency for Pigeons T2 and T3. The conjoint contingency was therefore made more stringent. This was accomplished by changing the time-in : timeout ratio from 2:1 (time-in = 120 s; timeout = 60 s) to 1:5 (time-in = 30 s; timeout = 150 s). Thus, overall cycle duration was held constant at 180 s while the relative durations of time-in and timeout changed. In the absence of responding, 150-s timeouts now occurred every 30 s. For Pigeons T2 and T3, a new baseline was established with the 1:5 ratio before the conjoint schedule was introduced. For Pigeons T1 and T4, the 1:5 ratio was introduced following the first reversal phase at 2:1 while the conjoint schedule remained on the same key. Because time-in cycles were now one quarter of their original length, however, conjoint ratio size for these 2 subjects was reduced to 25% of its previous value.

Two reversal phases were undertaken with Pigeons T1, T2, and T4. A strong position bias was still evident for T3. The forced-choice procedure was, therefore, reintroduced for T3 as a means of establishing contact with the conjoint contingency. This, too, was unsuccessful in shifting responding to the conjoint key in two-key choice sessions. Therefore, several additional attempts to shift responding toward the conjoint key were undertaken. The pre-session forced-alternation procedure was extended from 12 min to 25 min (20 sessions) and to 45 min (14 sessions), with little effect. The time-in : timeout ratio was changed from 1:5 to 1:10 (time-in = 15 s; timeout = 150 s) for 61 sessions, the final 23 of which included a 25-min pre-session forced-alternation procedure. Baseline conditions under the standard 1:5 time-in : timeout ratio were then reintroduced, with the remaining conditions similar to those of the other subjects. For all 4 subjects, at least one reversal phase was conducted at the 1:5 ratio.

Experimental conditions were maintained for a minimum of 20 sessions and until daily response rates were deemed stable via visual

inspection. A maximum of 60 sessions were conducted per condition, except during baseline phases, during which no upper limit was imposed. One exception was Pigeon T3 under the sequence of conditions constituting the 1:5 time-in : timeout ratio. Due to time constraints brought on by months of additional training, a maximum of 30 sessions per condition was imposed. Table 1 summarizes the order and number of sessions per condition. Sessions were conducted 7 days per week throughout the experiment.

## RESULTS

The results are summarized in Table 1, which presents for each subject response and reinforcement rates on both keys and session time in the presence of RI and timeout periods, averaged over the final six sessions of each experimental condition. Throughout the experiment, key pecking was maintained at fairly high uniform rates during RI periods and at very low (near-zero) rates during timeouts. Under baseline conditions, when pecking either key had equivalent effects, relative response rates favored the left key for 3 of the 4 pigeons. Although mean response rates for the other pigeon (T1) indicated a slight preference for the right key, response rates in 10 of the final 15 baseline sessions for this subject were actually higher on the left. Therefore, for all 4 subjects, the conjoint schedule was arranged initially on the right key.

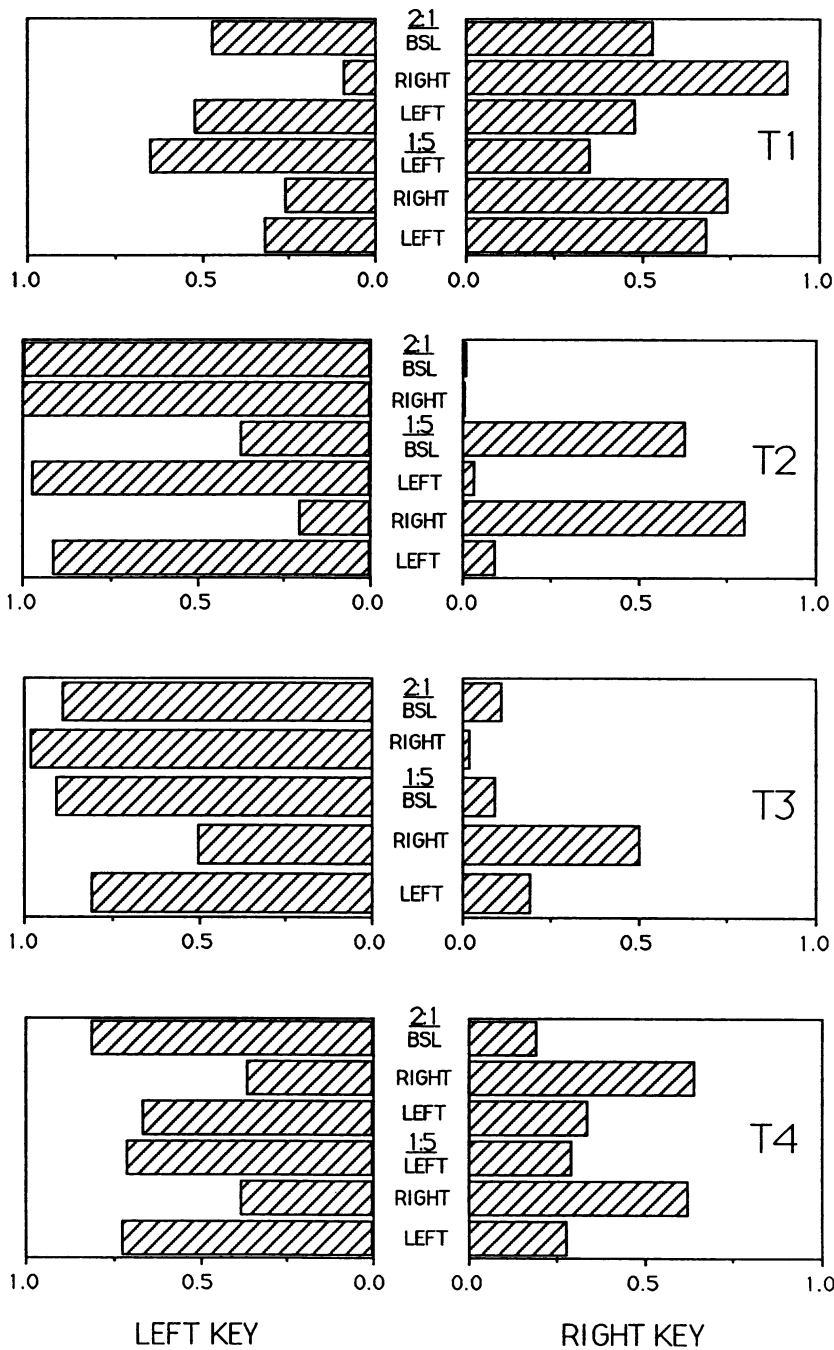
Figure 1 shows the relative response rate (frequency of key pecking on one key divided by the combined frequency on both keys) of each subject across experimental conditions. For each condition, the data are arrayed horizontally; successive conditions are presented vertically. Under the time-in : timeout ratio of 2:1, 2 (T1 and T4) of the 4 pigeons' responding was sensitive to the timeout-deletion contingency, as evidenced by a systematic shift in response allocation favoring the conjoint alternative. The distribution of key pecking shifted for both pigeons, first to the right key and then to the left, as the consequences of responding on the two keys were reversed, demonstrating that the initial effect was not simply an artifact of the forced-choice procedure. For the other 2 pigeons, a strong position bias overrode the consequences provided by the

Table 1

Response and reinforcement rates on each key and session time in the presence of time-in (TI) and timeout (TO), averaged over the final six sessions in each condition for each subject. Standard deviations are shown in parentheses. Also shown are conjoint ratio sizes and the number of sessions conducted in each condition. L (left) and R (right) refer to the location of the key on which the conjoint schedules consequences were arranged, B to baseline conditions, and 2:1 and 1:5 to time-in:timeout ratios.

Subject	Procedure	Conjoint ratio	Responses per minute		Reinforcers per minute		TI (min)	TO (min)	Sessions
			Left	Right	Left	Right			
T1	B 2:1	—	56.6 (12.9)	64.3 (18.2)	0.65 (0.11)	0.70 (0.21)	32.3 (0.9)	15.8 (0.4)	82
	R 2:1	174	10.8 (4.9)	113.3 (7.9)	0.10 (0.06)	1.27 (0.18)	36.5 (1.1)	9.3 (1.5)	50 <sup>a</sup>
	L 2:1	112	62.2 (12.1)	58.3 (11.9)	0.51 (0.11)	0.65 (0.14)	36.9 (1.8)	9.5 (2.1)	36
	L 1:5	28	77.0 (5.3)	41.6 (5.2)	0.78 (0.19)	0.46 (0.21)	18.1 (1.8)	29.2 (1.9)	21
	R 1:5	36	36.7 (10.6)	101.7 (15.3)	0.31 (0.11)	0.94 (0.10)	19.6 (6.0)	26.9 (5.0)	34
	L 1:5	39	37.3 (13.0)	80.9 (41.5)	0.52 (0.20)	0.86 (0.17)	12.0 (2.4)	36.0 (1.8)	60
T2	B 2:1	—	109.2 (11.0)	0.7 (0.7)	1.27 (0.21)	0.01 (0.01)	30.7 (1.2)	15.8 (0.4)	33
	R 2:1	89	96.5 (4.6)	0.1 (0)	1.41 (0.23)	0.0 (0.01)	32.1 (0.9)	14.3 (0.5)	49 <sup>a</sup>
	B 1:5	—	23.6 (10.1)	40.8 (9.8)	0.45 (0.28)	0.56 (0.15)	8.4 (0.8)	40.0 (0)	36
	L 1:5	20	97.1 (9.4)	3.4 (1.6)	1.30 (0.14)	0.07 (0.06)	30.8 (5.5)	14.6 (5.7)	35
	R 1:5	21	15.2 (2.6)	60.4 (5.9)	0.24 (0.04)	1.21 (0.19)	21.8 (1.9)	25.0 (1.4)	33
	L 1:5	20	70.9 (6.5)	6.8 (2.6)	1.03 (0.10)	0.20 (0.08)	24.8 (4.4)	21.7 (4.9)	23
T3	B 2:1	—	47.9 (3.6)	5.8 (2.4)	1.08 (0.23)	0.09 (0.04)	32.8 (0.8)	16.0 (0)	42
	R 2:1	50	64.5 (8.1)	1.6 (1.0)	1.21 (0.10)	0.04 (0.05)	33.5 (1.6)	11.7 (0.9)	45 <sup>a</sup>
	B 1:5	—	31.8 (2.3)	3.1 (2.6)	1.05 (0.29)	0.03 (0.07)	8.4 (0.9)	40.0 (0)	20
	R 1:5	8	27.0 (11.1)	27.0 (15.6)	0.68 (0.40)	0.62 (0.31)	24.0 (10.5)	22.5 (11.3)	30 <sup>a</sup>
	L 1:5	19	41.4 (5.0)	9.7 (5.6)	1.11 (0.18)	0.22 (0.15)	42.2 (5.1)	2.9 (5.5)	28 <sup>a</sup>
	B 2:1	—	86.2 (11.2)	20.7 (3.1)	0.97 (0.16)	0.22 (0.10)	32.5 (1.0)	16.2 (0.4)	45
T4	R 2:1	110	38.0 (3.1)	66.2 (2.1)	0.41 (0.15)	0.99 (0.18)	40.9 (1.3)	4.7 (1.1)	52 <sup>a</sup>
	L 2:1	129	70.8 (5.7)	36.4 (4.6)	0.66 (0.11)	0.60 (0.12)	41.8 (0.9)	4.5 (0.8)	53
	L 1:5	32	107.7 (9.8)	43.5 (15.5)	0.87 (0.21)	0.44 (0.18)	23.0 (8.0)	24.2 (9.0)	42
	R 1:5	43	54.2 (6.3)	86.6 (5.2)	0.42 (0.18)	0.69 (0.14)	19.9 (1.9)	27.5 (2.0)	41
	L 1:5	44	99.9 (11.5)	39.2 (5.2)	0.87 (0.17)	0.47 (0.12)	18.9 (2.3)	28.7 (1.9)	36

<sup>a</sup> Due to the forced-choice procedure, some sessions were conducted on alternate days.



RELATIVE RESPONSE RATE

Fig. 1. Relative response rates (frequency on one key divided by the combined frequency on both keys) averaged over the final six sessions of each experimental condition. The data are arrayed horizontally; successive conditions are presented vertically. "RIGHT" and "LEFT" refer to the key on which the conjoint scheduled consequences were arranged; 2:1 and 1:5 represent time-in:timeout ratios. See text for details.

conjoint schedule. Despite forced exposure to the right (conjoint) key on alternate sessions, clear preference for the left key prevailed.

A more detailed characterization of performance is provided in Figure 2, which presents absolute RI response rates on each key in blocks of three sessions across all conditions of the experiment. For Pigeons T1 and T4, changing the time-in:timeout ratio from 2:1 to 1:5 further differentiated response rates on the two keys. For T4, responding shifted appropriately in favor of the conjoint key during two subsequent reversal phases, providing further evidence of the effectiveness of the timeout-deletion contingency. Similarly, the responding of Pigeon T1 proved sensitive to a procedure reversal (right 1:5), but failed to recover when the conjoint contingency was moved back to the left key.

The responding of Pigeons T2 and T3, which proved insensitive to the conjoint schedule under the 2:1 time-in:timeout ratio, changed dramatically under the 1:5 ratio, even before the conjoint contingency was imposed. Under the reestablished 1:5 baseline, response rates decreased to about half of the original baseline. The strong initial position preference was still evident for Pigeon T3, but relative rates now favored the right key in Pigeon T2. In contrast to behavior under the 2:1 ratio, the responding of T2 proved sensitive to the timeout-deletion contingency, as the allocation of key pecking shifted in favor of the conjoint key. As with Pigeons T1 and T4, the effects were replicated in subsequent reversal phases. The effects of the conjoint scheduled consequences were much weaker for Pigeon T3. The forced-choice procedure was reinstated on some alternate sessions in the final sequence of conditions as a means of providing contact with the conjoint contingency. Conjoint response rates did increase moderately, but the effects were far less robust than for the other subjects. Some early effects were evident under the 1:5 ratio but quickly disappeared following a key failure midway through the right 1:5 condition. Although terminal response rates in this condition were higher on the conjoint (right) key, the session limit was reached before responding had fully stabilized.

The relationship between conjoint-schedule response rates and conjoint ratio requirements is shown in Figure 3. Due to different cycle lengths under 2:1 and 1:5 time-in:timeout ra-

tios, ratio sizes were normalized by converting them to their responses per minute equivalent. Across all 4 subjects, conjoint-schedule response rates met or exceeded ratio requirements in 14 of 17 conditions—all of the conditions in which a reversal of preference occurred in favor of the conjoint key.

## DISCUSSION

The present study examined control of behavior by two distinct sources of reinforcement; key pecks on the conjoint-schedule key both produced occasional food deliveries and extended the period of time in which those food deliveries were available. Responding in 3 of 4 subjects favored the alternative with the conjoint scheduled consequences, demonstrating sensitivity to the conjoint contingency. By arranging the conjoint contingency on the initially less preferred of the two keys, sensitivity to that contingency was shown to be more than a simple artifact of position bias toward one alternative. The reliability of the effect was demonstrated by systematic performances during subsequent experimental phases, in which the consequences of responding on the two keys were reversed. In these 3 subjects, appropriate shifts in responding favoring the conjoint key were evident in 12 of 14 experimental conditions. In each of those cases, conjoint-schedule response rates equaled or exceeded the ratio requirements arranged on that key (Figure 3). One of the two failures to obtain a preference reversal (Pigeon T1 in the second left 1:5 condition) may have been related to an equipment malfunction (a key failure during Session 20 in that condition) after which responding shifted abruptly to the alternate (right) key, where it remained for much of the rest of the study. In a 4th subject (T3), the conjoint contingency exerted some control over responding after extensive training, but the effects were transient and weak.

The results are in qualitative agreement with previous studies of negatively reinforced behavior (Baron et al., 1977; DeWaard et al., 1979; Mellitz et al., 1983), in which responding entered into two distinct contingencies—one that avoided individual shocks and one that terminated the situation in which those shocks were delivered. In the present case, the conjoint contingency allowed for responses to extend, rather than terminate, a second set of contin-

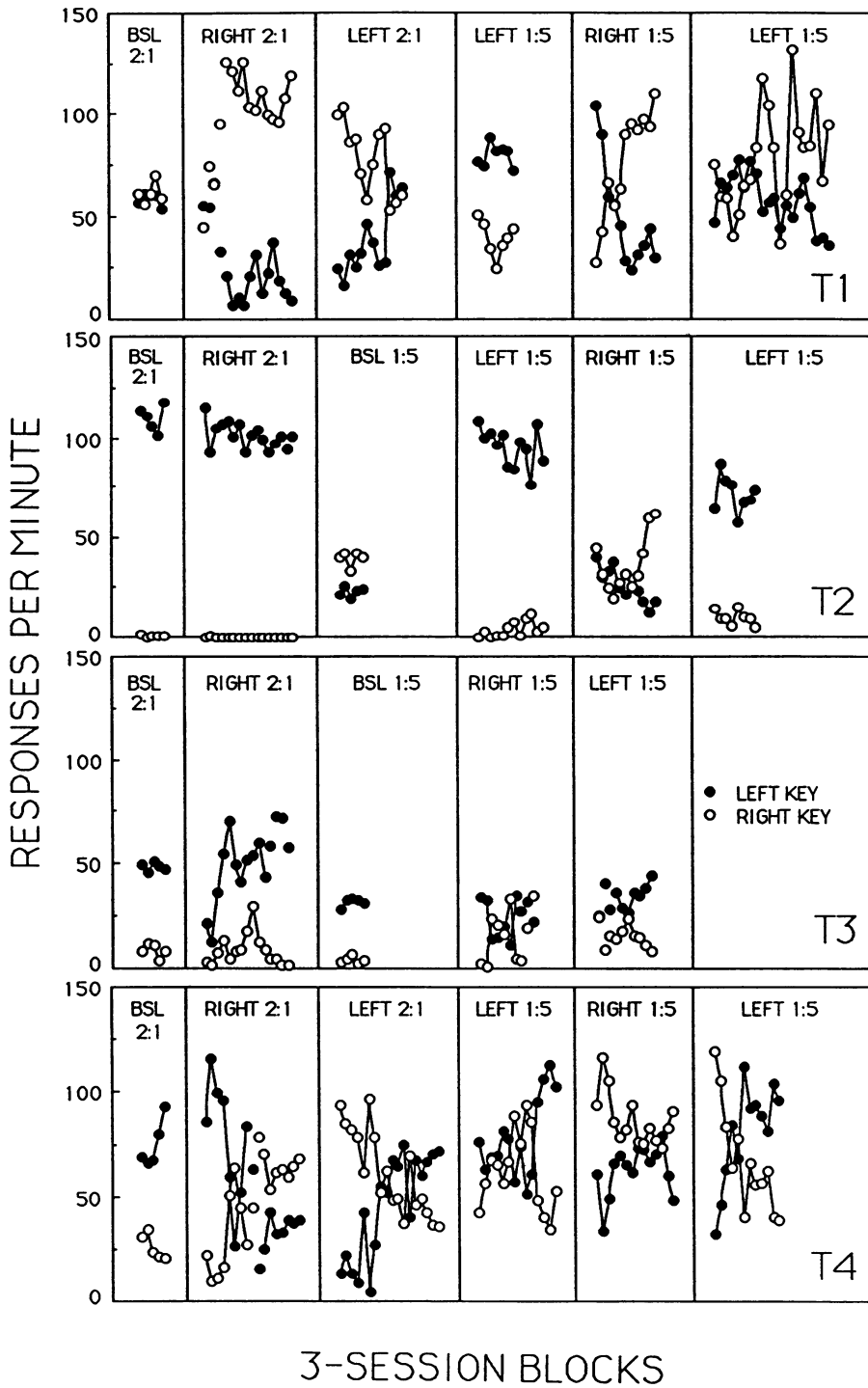


Fig. 2. Overall rates of key pecking, expressed as three-session means, across the final 15 baseline sessions and all other sessions for each subject. The open points represent right-key response rates, and the solid points denote left-key rates. Unconnected points within a condition indicate sessions between which the forced-choice procedure intervened. "RIGHT" and "LEFT" refer to the key on which the conjoint scheduled consequences were arranged. As before, 2:1 and 1:5 represent time-in:timeout ratios.

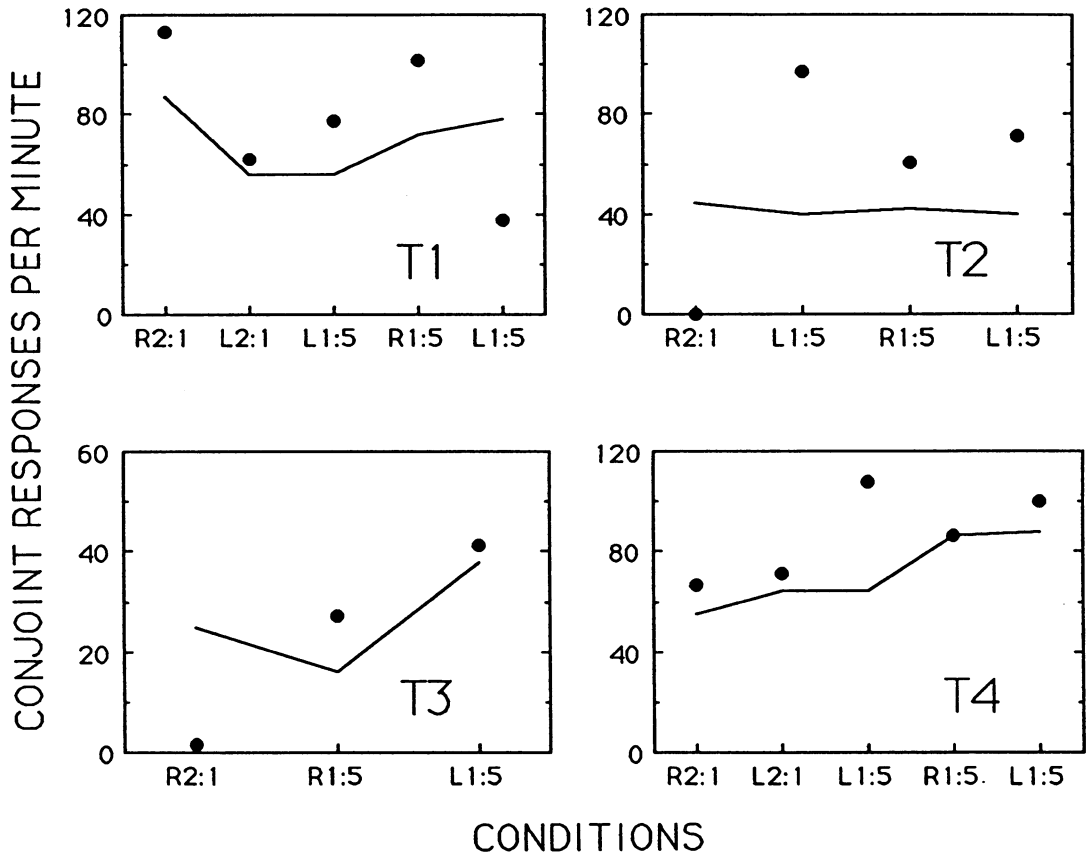


Fig. 3. Responses per minute emitted (circles) and required (line) across successive conditions for each subject. Data points are means across the final six sessions of each condition. "L" and "R" stand for left and right, respectively, and 2:1 and 1:5 denote time-in : timeout ratios.

gencies. To the degree that extending time-in periods also entailed canceling signaled extinction periods, the results can also be viewed as consistent with studies demonstrating the reinforcing effectiveness of avoiding periodic timeouts from ongoing schedules of food delivery (Ferster, 1958; Galbicka & Branch, 1983; Mechner & Ray, 1959; Morse & Herrnstein, 1956; Thomas, 1964, 1965). In this domain, timeouts are usually treated as aversive events, analogous to more common aversive stimuli such as electric shock. This has led to a consideration of timeout avoidance in terms consistent with aversive control more generally (Leitenberg, 1965).

The most common procedures in either the shock-avoidance or timeout-avoidance domains involve postponement contingencies (Sidman, 1953), in which responses delay impending events (shock or timeout). Timeout-

avoidance response rates in such procedures are inversely related to the interval whereby responses postpone timeouts (Ferster, 1958; Galbicka & Branch, 1983), in much the same way that shock-avoidance rates vary inversely with the response-shock interval (Clark & Hull, 1966; Sidman, 1953). In postponement procedures, response rates are constrained by temporal relations between responding and scheduled timeouts, as the timing cycle is reset by each avoidance response. In deletion procedures like those used in the present experiment, however, the timing cycle proceeds independently of behavior; prescheduled timeouts can be canceled by effective responding at any time during the cycle in which they are programmed. Consistent with the shock-avoidance case, in which responding is established and maintained by both deletion and postponement contingencies (Hineline, 1977), the

present results suggest that avoiding timeouts may share important features with avoiding shock.

However, as pointed out in an early review of this domain (Leitenberg, 1965) and echoed more recently (Galbicka & Branch, 1983), research involving timeout from reinforcement is frequently subject to dual interpretation. The present data are no exception. Whether timeouts are deleted as in the present study or postponed as in prior studies, lowering the frequency of timeouts yields a corresponding increase in the frequency of positive reinforcement (see Table 1). The effective consequences, then, can be viewed in terms of either (a) avoiding timeout periods (negative reinforcement), or (b) extending time-in periods, thereby increasing the overall frequency with which positive reinforcers occur (positive reinforcement). This latter view implies control by remote food deliveries, but under typical postponement procedures increased reinforcement frequency may be a simple artifact of control by local temporal (pacing) contingencies. More promising are deletion procedures, in which response rates are free to vary with reinforcement variables and thus more accurately reflect reinforcing effectiveness (de Villiers, 1974). The present results seem to argue in favor of sensitivity to remote food deliveries, although the parameters used here only hint at the potential time frame over which such sensitivity occurs. As a modest preliminary investigation, this study raises perhaps more questions than it answers, but it points to a promising set of procedures that appear well suited to assess in greater detail the time scales of behavior-environment interaction. It should prove interesting, for example, to expand the time-in/timeout cycles to durations approaching an experimental session, as well as to assess variations in economic context that span beyond those sessions.

A more proximal source of control in the present procedures that cannot be overlooked is adventitious response-timeout pairings. Timeouts, when allowed to occur, were more likely to follow responses on the nonconjoint key than on the conjoint key. This adventitious correlation between timeouts and nonconjoint responses may have suppressed responding on that alternative, thereby contributing to the shifts of responding in favor of the conjoint key. Mellitz et al. (1983) avoided this con-

founding effect by suspending the session-shortening contingency during the final 2 min of each session. Responses on either lever were then equally likely to precede session termination. Had the conjoint contingency in the present experiment been similarly disabled prior to each timeout, explanations appealing to adventitious punishment could be ruled out.

Although plausible, interpretations based on adventitious punishment are weakened by the results of a recent study by Dunn (1990), in which response-contingent timeouts were explicitly arranged for responses on unequal concurrent schedules of food reinforcement. Unlike shock, increases in the frequency and intensity of which increase preference for the richer food-reinforced alternative (de Villiers, 1980; Farley, 1980), timeout frequency and duration were inversely related to preference for the richer of two variable-interval schedules of food presentation. Thus, even when explicitly contingent on behavior, timeouts failed to produce effects similar to those of response-contingent shock. It is unlikely, then, that occasional response-timeout pairings on the nonconjoint key in the present procedure could account for the systematic effects. Although inconsistent with previous studies involving shock, Dunn's data are consistent with manipulations of overall rate of positive reinforcement in concurrent schedules (Alsop & Elliffe, 1988; Logue & Chavarro, 1987).

Whether manipulations involving timeout from reinforcement are best characterized under the rubric of positive or negative reinforcement may be largely a matter of theoretical taste (Galbicka & Branch, 1983), especially in light of claims that fundamental differences between positively reinforced and negatively reinforced behavior may have more to do with the theories, than with the facts, of avoidance (Hineline, 1984). Traditional theory is rooted in a specific set of procedures, which has tended to limit the range of circumstances under which avoidance has been studied. When these circumstances are expanded, as in the present experiment, the commonalities between avoidance and other behavioral phenomena come into sharper focus.

This is not to suggest that meaningful distinctions between positive and negative reinforcement cannot be maintained; rather, those distinctions are based on function, not on procedure and/or type of consequence. Even then,

clear distinctions between presentation and removal of stimulus changes may sometimes appear arbitrary (Michael, 1975). Although this is a legitimate point of concern, the directionality of environmental change is only one aspect of the distinction between positive and negative reinforcement; others include the types and ranges of events that function as effective consequences and the time frame in which those events operate (Hineline, 1984).

In addressing these latter concerns, it may be useful to broaden our analyses to include simultaneous, complementary patterns of behavior on multiple time scales. Recent accounts of avoidance stress the importance of ongoing behavioral situations (e.g., Baum, 1973), the reinforcing or aversive properties of which depend not only on changes in density of primary reinforcing or aversive stimuli that they delineate, but also on contingencies that govern transitions to alternative situations. Discriminable changes of situation are viewed as potent sources of negative reinforcement (DeWaard et al., 1979; Perone & Galizio, 1987), analogous to the reinforcing effects of transitions between links in chained schedules of positive reinforcement (Baum, 1974). It may then be possible to examine both positive and negative reinforcement within a single analytic framework (de Villiers, 1974; Hineline, 1984; Perone & Galizio, 1987).

The present results are consistent in broad outline with this viewpoint. Responding was maintained both by a schedule of food presentation in one situation and by preventing transitions to less favorable contingencies. The extent to which such transitions are reinforcing or aversive depends on a number of factors—short-term and long-term changes in reinforcement density, contingencies involved in getting from one situation to another, stimuli correlated with those transitions, to name just a few—but it is becoming increasingly clear that these factors are relevant to both positive and negative reinforcement.

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